From: D.M. Olson
To: UICRegulations@DOC
Subject: ATTN: UIC Discussion Draft
Date: Wednesday, February 17, 2016 5:49:13 PM

I have several comments on the proposed regulations as posted on the Dept. of Conservation's website.

1724.7 (1) (B): "Reservoir characteristics of each injection zone, such as porosity, permeability, average thickness, areal extent, fracture gradient, original and present temperature and pressure, and original and residual oil gas, and water saturations..."

This appears to call for a more comprehensive geological and reservoir properties characterization of the proposed injection zone than was previously required. Depending on how these requirements are interpreted, there could be some confusion. I list some questions below that I would have if asked to prepare a UIC submission with only this wording:

Porosity: Porosity does not vary significantly through most zones in a typical California reservoir, so a single average value is probably acceptable in most cases. Producing reservoirs will nearly all have sufficient log and core data to provide a good porosity value. Proposed wastewater injection zones, if they are wet sands above or below the producing zone, often do not have core or sidewall samples to provide laboratory porosity, but at least somewhere a porosity log was probably run which can give a reasonable value.

Permeability: This is a very difficult subject, and one that we have worked with extensively in our petrophysical consulting practice. What type of permeability the Department should require depends on what the intended use is. Valid reservoir permeability data can include: air permeability measured from core in the lab at surface conditions, air permeability corrected to downhole conditions, estimated brine permeability at reservoir conditions, permeability from a calibrated log transform, and interval average flowing permeability estimated from flow tests, among others. The source of the permeability estimate should be mentioned along with the values. Average permeability is not very meaningful for most reservoirs, and also does not provide a good indication of reservoir performance, a range of values would be more useful. Permeability varies by up to 2 orders of magnitude within most reservoirs, though in practice almost all of the fluid will enter the most permeable part of the injection zone and virtually none will enter the low-permeability rock. For a zone that is or was a producing reservoir, core or sidewall analyses are usually available to provide a range of permeability. For proposed wastewater injection zones that are above or below producing reservoirs, there may be no core data of any kind and permeability will have to be estimated from log transforms or other indirect means.

Original and residual oil, gas, and water saturations: These parameters would obviously only apply to current or former producing reservoirs. They are clearly very important parameters but it usually requires an entire reservoir study to determine what they are. Unless the operator

has done extensive special core analysis, which has seldom been done, the values will generally be estimates, although probably these estimates will be accurate enough for the purposes of a UIC application. In our experience, for most reservoirs original oil saturation was likely between 65%-85% and residual So will be around 20%-25%, though some reservoirs are as high as 30%. We saw one where residual So was 45%. Thermal operations can drive residual saturation down as low as 10% in good quality sands. The economic limit will likely be reached long before the reservoir has actually been produced to the point of residual saturation. I make these comments in case the Department wants to clarify the purpose for requesting these parameters.

1724.7 (2) "A geologic study including but not limited to:...representative electric log to a depth below the deepest producing zone...)"

A representative porosity log should be requested also, if available. In most situations, I think porosity logs will be available.

1724.7 (H)(6) "Examples of such data are: isogor maps, water-oil ratio maps, isobar maps..."

I am not sure what a water-oil ratio map is. We routinely construct So or Sw maps, which would provide (I think) the information you are asking for here.

1724.10 (j)(2) "The second part of the MIT is not required for a cyclic steam well that has never injected more than 100 gallons per foot"

This might be better expressed in the industry standard barrels, 100 gallons is approximately 2.5 barrels. The statement is unclear, does it mean 100 gallons/ft of total zone, or perforated zone? Another way of calculating steamflood injection is BBL/acre-foot of reservoir volume, is that the intended meaning? Does it mean absolute total injection volume? If it refers to a rate, over what period of time? Per day? This just needs clarification.

Thank you.

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